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AUTHOR: Zhuk, I. P.

TITLE: Calculation of the temperature field of a multilayered wall

PERIODICAL: Inzhenerno-fizicheskiy zhurnal, v. 5, no. 10, 1962, 100 - 103

TEXT: This is studied for the following cases: (a) the temperature field on the outer surface changes harmonically ($t_1(o,\tau) = t_{10} + t_m \cos\omega\tau$, $t_1(o,o) = t_{10} + t_m = T_1$), while the temperature on the inner surface remains constant: ($t_n(l_n,\tau) = T_n$). (b) The temperature field on the outer surface changes harmonically ($t_{10} + t_m \cos\omega\tau = t_1(0,\tau)$, $t_{10} + t_m = T_1$), while on the inner surface heat is exchanged with a medium at constant temperature ($\lambda_n \partial t_n/\partial x = -\alpha(t - t_{mean})|_{x = l_n}$. The general solution

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$$t_k(x,\tau) = d_k x + b_k + t_m\,[\Phi_k(p,x,\tau)|_{p=0} + \mathrm{Re}\,\Phi_k(x,p,\tau)|_{p=i\omega}] + \sum_{j=1}^{\infty} A\,\Phi'_k(p,x,\tau)|_{p=-\mu_j^2},$$

$$\Phi_k = \frac{\Delta_k e^{q_k x} + \Delta_{-k} e^{-q_k x}}{\Delta} \exp(p\tau);\quad q_k = \sqrt{\frac{p}{a_k}}; \qquad (2)$$

$$\Delta = \begin{vmatrix} 1 & 1 & 0 & 0 & \dots & 0 \\ a_{11} & a_{12} & a_{13} & a_{14} & \dots & a_{1\,2n} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ a_{2n-1\,1} & a_{2n-1\,2} & a_{2n-1\,3} & a_{2n-1\,4} & \dots & a_{2n-1\,2n} \end{vmatrix}$$

to system

$$\frac{\partial t_k}{\partial \tau} = a_k \frac{\partial^2 t_k}{\partial x^2} \quad k = 1, \dots, n; \qquad (1)$$

$$t_{k+1}(l_k,\tau) = t_k(l_k,\tau);\quad \frac{\lambda_k}{\lambda_{k+1}} \frac{\partial t_k}{\partial x} = \frac{\partial t_{k+1}}{\partial x}\Big|_{x=l_k}$$

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of this problem takes the form

$$t_1(x, \tau) = d_1x + b_1 - t_m [A_1(x) - B_1(x)\cos(\omega\tau - \gamma + \beta_{1x})] + \sum_{j=1}^{\infty} D_1(x)\exp(-\mu_j^2\tau), \quad (3)$$

$$t_2(x, \tau) = d_2x + b_2 - 2t_m [A_2(x) - B_2(x)\cos(\omega\tau - \gamma - \beta_{2x})] + \sum_{j=1}^{\infty} D_2(x)\exp(-\mu_j^2\tau), \quad (4)$$

$$t_3(x, \tau) = d_3x + b_3 - 4t_m [A_3(x) - B_3(x)\cos(\omega\tau - \gamma - \beta_{3x})] + \sum_{j=1}^{\infty} D_3(x)\exp(-\mu_j^2\tau), \quad (5)$$

for a three-layered wall. This solution is discussed for the cases (a) and (b). Thus it is possible to calculate the heat transfer through a wall in which the heat is multiply reflected, also to determine the times when thermal oscillations occur and when the maximum temperature is attained.

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ASSOCIATION: Energeticheskiy institut AN BSSR, g. Minsk (Institute of Power Engineering AS BSSR, Minsk)

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